There is also a definite increase in the average weight. The detailed data of this part of the investigation will be presented in a later paper, together with the evidence which shows that this increase in weight and height has occurred in spite of the fact that the average age of the women entering the University has grown less. The racial as well as economic importance of these changes, which point to a more fully developed and more perfectly functioning type of woman, can hardly be overestimated.

RELATIONSHIP BETWEEN TRAUMA AND MALIGNANT DISEASE FROM AN INDUSTRIAL VIEWPOINT

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Before entering upon a discussion of the relationship of trauma to malignant disease from the point of view of one who wishes to determine fairly the connection of an industrial accident with the subsequent development of a malignant growth, it may be well to look upon the question from a purely scientific standpoint and to ask ourselves what warrant is there to assume, that there may be such a connection.

It is common knowledge, that our information in regard to the etiology of tumor is woefully deficient. What the final cause of them is, if there is any single such, we do not know, but we are gradually learning to connect up the development of tumors with other types of proliferative processes of which we have a better understanding; may they be due to abnormalities in development, to inflammation, or may they be connected with the more normal processes of hypertrophy and regeneration. The general impression is, that any change which is associated with tissue proliferation may terminate in the development of true tumor. Other things being equal this transformation occurs the more readily the more actively the tissues are proliferating and the longer the tissue proliferation has continued. It is also evident that this transformation is fortunately a rare occurrence. Pathological tissue proliferations due to one cause or another are exceedingly common. There is hardly any human being, or any living organism for that matter exempt from them, but tumors we meet with only occasionally. It is this which has made many investigators feel, that something new must happen to convert these ordinary tissue proliferations into tumorous growths, but on close analysis may we not find, that the difference is merely a quantitative not a qualitative one, i. e., that after all the same process continues only in a vastly exaggerated form in a more or less predisposed individual? The existence of intermediate stages, where even the best expert with all modern technical means at his disposal cannot decide whether they should be classified as tumors or whether they still belong to the other pathological conditions mentioned seems to point this way.

From these theoretical conditions it will be evident that trauma can contribute to the development of tumors in so far as it causes tissue proliferation and, since any break in continuity, such as is likely to occur as a result of the trauma, is sure to be followed by regenerative and often by inflammatory proliferative processes, the possibility certainly exists that these may go on to the development of true tumors.

It would also appear, as if repeated and continued traumatic influences would be more likely to terminate in tumor production than a single trauma followed by a reaction of limited duration, and this surmise is amply born out by practical experience. The most numerous and best authenticated cases of post-traumatic tumor formation belong to this group. To mention but one example; so many cases of carcinoma arising in scars or chronic ulcers from old burns have been reported in literature, that there cannot any more be a question of the etiological relation of the one to the other, and the same is true, as we all know, of other types of chronic ulcerations of the skin and mucous membranes in the production and maintenance of which trauma may play an important role.

The relation of single trauma to tumor is much more doubtful, and it is quite generally stated that there is no case so far recorded in literature which proves this connection with scientific accuracy, but that there is sufficient evidence to make it justifiable to give to patients for whom the question of insurance depends on our decision, the benefit of the doubt.

It is interesting to follow the development of our knowledge in this field and to notice how gradually the circumstances under which such a connection is assumed have become more and more restricted, and our attitude toward the question more and more conservative.

Samuel Gross [1] in 1897 made the statement, that among the 144 cases of sarcoma of the long bones which he had been studying one-half of those in which the etiology was recorded were due to traumatism. They could be traced to blows, falls, kicks, sprains, fractures and other injuries.

A thorough discussion of the problem commences with an elaborate paper of Loewenthal,[2] from Bollinger's laboratory in Munich in 1875 which includes the presentation of 800 short case-records without much critical analysis of them, however. For this reason the majority of them are worthless from a scientific point of view, but at the same time he reports a considerable number of very interesting and suggestive observations as, for instance, several cases in which sarcoma developed at the site of old fractures and in old gun-shot wounds.

Coley [3] follows in 1898 with an article on the influence of injury upon the development of sarcoma. He studied 70 cases of sarcoma among which there was a history of trauma in 46 (27%). A careful analysis of the records of the 46 cases shows, that not more than one-half of them are fairly convincing. Coley develops the idea; that the trauma localizes the unknown cause of cancer as it is apt to do in infectious diseases like tuberculosis.

Another extensive, rather early publication (1906) on our subject is that of Roepke [4] who

reports on 800 carcinomata and 186 sarcomata. He also fails in the critical selection of his cases especially where a single trauma had occurred.

Since then with the introduction of protective legislation in industrial accidents in Europe and in our own country gradually certain rules have been laid down which must be fulfilled before the development of a tumor can be looked upon as the result of an industrial accident. The whole subject was thoroughly discussed at the second international conference on cancer at Paris in 1910, by Bérard [5] and by Thiem,[6] both eminent authorities in our subject in their respective countries.

These rules have been variously formulated, but there is a fairly good consensus of opinion on the essentials as follows:

1. The occurrence of the trauma must be proved.
2. The trauma must have been severe enough to appear effective.
3. The growth must develop at a place likely to have been injured by the trauma.
4. It must be reasonably certain that the traumatized part was normal before the accident.
5. The time elapsing between the trauma and the appearance of the tumor must agree with our scientific experience in the rapidity of the development of the particular kind of tumor under consideration. The time must not be too short, not less than several weeks, nor too long. The outside limit is usually given at about two years, but a reasonable connection may be assumed even in cases in which the interval is much longer, if there are symptoms which bridge over the intervening period.

Condition 4 is the one which is most difficult to fulfill, and it is the one which must be fulfilled, if a *scientific* proof of the causal relation of trauma to tumor is to be furnished.

Condition 5 is the one that is most frequently sinned against in decisions in regard to industrial accidents. This is especially true in regard to sarcomata of the bone. If a noticeable tumor in this region follows a comparatively trivial injury in a few days, it is almost certain that the growth preceded the injury. This is also true in cases in which the injury to the bone was unusually painful or caused more damage than one would suspect from its nature.

As a result of the more careful analysis of the cases the percentage figures of tumors really ascribable to injury has been decreasing very much. In his hand-book on "accident medicine," Kaufmann [7] states that there seems to be a reasonable connection between trauma and benign tumors in two per cent., between trauma and carcinoma also in about two per cent., and between trauma and sarcoma in five per cent. of the cases, and Loewenstein [8] in a very instructive article from Czerny's clinic informs us that the statistics of the Prussian army and navy from 1899-1907 reveal a proportion of one case of post-traumatic malignancy in 15,000 accidents.

Our general conclusion then would be, that a single trauma not followed by complications is a rare cause of tumor, and each individual case must be subjected to a careful analysis before arriving at any conclusion. It is evident, that for such an analysis the data must be as complete as possible and very specific in regard to the findings at the time of the injury and as to the events which followed. It is unfortunate that many physicians who treat industrial accident cases do not as yet seem to have learned this lesson. A roentgenogram taken immediately after the injury would clear up many a doubtful case.

After these general considerations I may be permitted to briefly touch on a few special points.

Of benign tumors produced by trauma there have been mentioned: fibroma, lipoma, neuroma, osteoma, and enchondroma.

Neuromata are always traumatic and are not true tumors.

Many of the so-called osteomata are also not true tumors, but are hyperplastic processes associated with bone development following injury to the periosteum and the adjoining soft parts. The bony growths in the muscles of the thigh following injury resulting from horse-back riding are excellent examples of this type of pseudo-tumor.

I also believe that the very nature of lipomata makes the possibility of a traumatic origin of them exceedingly doubtful.

Fibromata, on the other hand, occasionally result from trauma, and the number of fairly well-authenticated cases of enchondroma following trauma is really quite astonishing. In their case the question naturally arises, whether the trauma did anything more than to stimulate the growth of an already pre-existing abnormal mass of cartilage, perhaps a piece of this tissue which had been misplaced embryologically. From our general knowledge of these tumors this appears to be very probable, but even such an occurrence would entitle the patient to compensation.

Sarcomata are supposed to be due most commonly to single trauma, whereas carcinoma is said to follow more frequently repeated and continued injury.

Among all sarcomata the sarcomata of bones are most frequently referred to trauma and, theoretically, the interrelation seems quite plausible, because any injury to bone, and particularly a fracture, is followed by the most remarkably vigorous production of new tissue. In fact the callus-production is often so exuberant, that it is difficult to decide, even microscopically, whether one is dealing with normal regenerative processes or tumor. On the other hand we have to be especially careful in these cases, because, since these growths are usually situated deep in the tissues, attention is often first called to them by some injury, trivial or severe, as the case may be, and also the existence of sarcoma in the bone predisposes the bone to ready occurrence of fracture, and other disturbances which may follow injuries. Kaufmann [7] estimates that twelve per cent. of the sarcomata of the bones are of traumatic origin. On the basis of a careful scrutiny of the cases reported, I personally believe that this percentage figure is still too high, but even the most skeptical observer must acknowledge that there are a

certain number of reports of such cases which are thoroughly convincing.

There is quite a literature on the relation of the development of glioma and of gliosarcoma to trauma, ever since the possibility of their traumatic origin was first suggested by Virchow. On account of the location of these growths, a decision in this matter is especially difficult and often altogether impracticable. I believe that a careful consideration of the probable rate of growth of such a tumor compared to the time which has elapsed since the injury would be very illuminating in many of them.

With the malignant tumors of the internal organs we encounter the same difficulties, and in very few of them is it possible to establish, even with a certain degree of probability, that they are the result of trauma.

Of the carcinomata of the surface epithelium it has already been stated that they follow chronic injuries very much more commonly than a single trauma, and there are, indeed, very few reports in literature in which the latter seems to be at all likely to have occurred.

Among carcinomata, carcinoma of the breast is most commonly referred to trauma by the patients, and yet the number of even fairly convincing reports of its traumatic origin is so small that some who have made a special study of this problem assert that there is no evidence to connect the development of these tumors with trauma.

So far as I have been able to ascertain, the carcinoma of the testicle is the only type of carcinoma which is frequently caused by a single more or less severe injury. This includes the so-called round-celled sarcoma of this organ, because careful histological examination reveals that most of these so-called sarcomata arise from the epithelium of the seminiferous tubules and, therefore, should be classified as carcinomata. The frequency of their traumatic origin, to my mind, has not been sufficiently emphasized, but anyone who has had experience with these growths will readily confirm it from personal experience, and a study of the case-reports collected in literature reveals the same thing. When we consider the constant and very active multiplication of the spermatogenous cells under normal conditions we may readily understand why a thorough, even single disturbance of them may lead to such disastrous consequences. The mere fact that these growths are usually encountered in comparatively young individuals, in the prime of sexual activity, lends strong support to this theory.

It would appear then, that in estimating the probability of a connection between trauma and the development of a true tumor, the collective experience so far obtained in the particular type of tumor concerned should also be carefully taken into account.

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Original Articles

HOW CAN MEDICAL SERVICE BE IMPROVED?*

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To attempt to cover this subject in one quarter of an hour without making some form of explanation or protest might be to acknowledge that medical service can be very little improved, if any. The contrary is the case. It may be vastly improved.

There is no intention in this paper to offer any suggestions for improvement in phases of the law itself. Whatever offering is made deals with the machinery now in use.

My purpose is to take up for consideration a number of subjects, offering briefly some suggestions.

The importance of Industrial Medicine and Surgery is not appreciated by the rank and file of the profession. It does not embrace simply the treatment of industrial injuries. It embraces all the phases of social medicine. The colleges are establishing courses in the subject. It embraces a large proportion of the total surgical and medical work.

The societies are taking it seriously. Let the individuals do likewise. Let the individuals consent to understand the problems. There are still frequent signs of lack of understanding. Many men would be saved much unhappiness if they realized for one instant the difference between the Industrial Accident Commission and the State Compensation Insurance Fund and other insurance companies. Some doctors will take the statements issued to them and the assertions made to them by insurance companies as Gospel. The doctors always have the right to recourse to the Industrial Accident Commission for authoritative information and suggestions.

We can make our work more scientific by early physical examination of selected cases. The hardest cases to fix responsibility in are those in which a physical impairment is superimposed on an injury and outlives it. Osteo-arthritis, tabes, lues, age defects, nephritis, diabetes; there are scores of ailments which are included by the injury in the results of injury. The Industrial Accident Commission has proposed to require an early examination in all injuries in:

1. Persons over 60 years of age.
2. The infirm or those of poor physique.
3. Injuries to head or thorax or abdomen.
4. Serious injuries of any kind.
5. Injuries which may involve nerves.

The committee of the State Medical Society and the committee of the insurance companies con-

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